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C-A OPERATIONS PROCEDURES MANUAL

7.1.7 Compressor Room - Second Stage Compressor Operation

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Hand Processed Changes

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Collider-Accelerator Department Chairman Date

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7.1.7 Compressor Room - Second Stage Compressor Operation

1. Purpose

This procedure covers the operation of a second stage compressor skid. Evacuation and purging operations are strictly manual and must be carried out at the compressor skid. Other operations can be performed either manually at the local control panel or via the Cryogenic Control Computer. This OPM contains the following procedures relating to the operation of the compressor skid:

Sections:
- 5.1 Emergency Shutdown
- 5.2 Skid Initialization
- 5.3 Startup
- 5.4 Shutdown
- 5.5 Evacuation
- 5.6 Purge
- 5.7 Safety Interlocks

2. Responsibilities

2.1 The Shift Supervisor, or an Operator designated by the Shift Supervisor, is responsible for conducting this procedure and providing documentation in the Cryogenic Control Room.

2.2 Should a problem arise during the completion of this procedure, the Shift Supervisor shall contact the Technical Supervisor for instructions before continuing.

3. Prerequisites

3.1 Operator shall be trained by the compressor room's cognizant engineer, and/or a person designated by the Operations Group Leader or Technical Supervisor, in the proper implementation of this procedure.

3.2 Operator shall become familiar with the second stage helium compressor P&ID 3A995020, and the physical location of components on the skids.

3.3 The skid has been prepared as follows:

3.3.1 The compressor and oil pump have been checked for alignment and rotation, the skid has been leak checked, all instrument gas supply valves have been opened, and all electrical disconnects have been energized.

4. Precautions

4.1 Lockout-Tagout procedures shall be used when servicing any component on a second stage compressor skid.

5. Procedure

5.1 Emergency Shutdown

The second stage compressor skid is outfitted with several safety interlocks and an emergency shutdown button mounted on the local control panel. When any of these devices are activated, the compressor and oil pump will automatically shut down, and the suction valve will close. If the system shuts down automatically, the local annunciator panel will light and identify which safety interlock activated the shut down.

[1] In the event of an emergency depress the emergency shutdown button.

[2] Immediately report to the shift supervisor for direction. Do not attempt to restart the compressor until all problems have been rectified. If the system has shut down because of a safety interlock, see section 5.7 for corrective action.

5.2 Skid Initialization

This procedure is to configure and check out the second stage compressor skid prior to being operated.

_____ [1] Switch hand switch HS2199 to the "LOCAL" position.

_____ [2] CONFIRM that all valves are in their initial positions according to C-A-OPM-ATT 7.1.7.a “Initial Valve Settings”.

_____ [3] CONFIRM that the system has been properly evacuated and backfilled with helium. If the system has not yet been evacuated, perform the evacuation procedures in accordance with section 5.5 of this OPM before proceeding.

_____ [4] CONFIRM that the helium pressure in the skid is 30 psi (PI2181). If not, backfill the skid using the purge supply valve H2183M.

_____ [5] CONFIRM both cooling water inlet and outlet valves are OPEN and adjusted for the proper flow. See C-A-OPM 7.1.5 (Compressor Room - Water System Operation) for instructions on adjusting the cooling water flow. If the "COOLING WATER FLOW LOW"

indicator light does not extinguish, there is a problem with the cooling water system and a supervisor should be informed. Do not continue until the problem is rectified.

_____ [6] CONFIRM that all lights on the local annunciator panel are extinguished. This means none of the safety interlocks are tripped.

_____ [7] PRESS the skid "RESET" button (HS2161). The blue "SKID RESET" light should light or remain lit.

_____ [8] CONFIRM that the skid's oil is reading at least 50% on LI2191E when the compressor and oil pump are not operating. If not, manually increase the oil level to 50% using the local hand switch HS2191 (oil make up valve E2187A).

_____ [9] Switch the "OIL MAKE UP" local hand switch (HS2191) to the AUTO position.

_____ [10] START the oil pump using the local hand switch HS2195. Allow the oil to circulate through the cooler, filter, and compressor. Check that 30 psi is established between PI2188E and PI2181H. If not, adjust E2191P. Observe the pressure loss between PI2188E and PI2198E. This should be less than 15 psi. If not, change the oil filter element. Oil level will gradually decrease while the oil pump is operating and the compressor is not.

_____ [11] Completely UNLOAD the compressor's slide valve using the hand switch HS2163 on the local control panel. The green "UNLOADED" indicator light should be lit and the visual indicator on the front face of the compressor should be in the UNLOADED position.

_____ [12] Manually OPEN the skid's main process discharge valve H2175M.

_____ [13] If the compressor is not going to be started within the next 5 minutes, STOP the oil pump.

_____ [14] RECORD in the Cryogenics Control Room Log Book that the compressor skid has been initialized.

5.3 Startup

This procedure is for starting up a second stage compressor skid. All operations in this section can be performed either at the compressor's local control panel or by the Cryogenic Control Computer. In the computer mode, the control room can

load and unload the slide valves, start and stop the compressor and oil pump motors, and open and close the suction valve. The discharge valve must be opened manually. Verify that the skid has been evacuated and purged according to sections 5.5 and 5.6 of this OPM.

_____ [1] CONFIRM that the Compressor skid has been initialized according to section 5.2.

_____ [2] Mode selector switch HS2199 must be in the "LOCAL" position to operate the compressor from the local control panel. The switch must be in the "COMPUTER" position to operate the compressor from the main control room.

_____ [3] START the oil pump. Allow the oil pump to run for 1 minute prior to starting a compressor.

_____ [4] UNLOAD the compressor's slide valve until it is at the "UNLOADED" limit. The compressor will not start unless the slide valve is in the fully unloaded position.

_____ [5] OPEN the skid's main process inlet valve H2176A.

_____ [6] START the compressor. Once a compressor is started a restart lock-out is activated. This lock-out keeps the compressor from being restarted for 1 hour.

_____ [7] After 1 minute of normal operation, a compressor's slide valve can be loaded as required.

Note:
The compressor skid can be switched from local to computer controlled mode and visa versa at any time. Switching modes will not change the state of any of the components on the skid. The Cryogenic Control Room shall be informed prior to changing the compressor skids control mode.

5.4 Shutdown

This procedure is for shutting down a compressor skid after a period of normal operation. All operations in this section can be performed either at the compressor's local control panel or by the Cryogenic Control Computer.

_____ [1] NOTIFY the Cryogenic Control Room that a compressor is going to be shutdown.

_____ [2] Mode selector switch HS2199 must be in the "LOCAL" position to operate the compressor from the local control panel. The switch must be in the "COMPUTER" position to operate the compressor from the main control room.

_____ [3] Completely UNLOAD the compressor's slide valve.

_____ [4] STOP the compressor.

_____ [5] After 1 minute, STOP the oil pump.

_____ [6] CLOSE the main process inlet valve H2176A.

_____ [7] RECORD in the Cryogenic Control Room Log Book that the compressor skid has been shut down.

5.5 Evacuation

This procedure is for evacuating and backfilling an individual second stage compressor skid. It shall be performed anytime the skid internals have been exposed to the atmosphere.

_____ [1] Switch hand switch HS2199 into the "LOCAL" position.

_____ [2] CONFIRM that the following valves are CLOSED; H2175M, H2176A, H2183M, and H2190.

_____ [3] CLOSE valves E2183M and E2195M.

_____ [4] OPEN the evacuation header valve V2189M and EVACUATE the skid to approximately 500 microns as measured at the vacuum skid.

_____ [5] CLOSE the evacuation header valve V2189M.

_____ [6] Using the purge supply valve H2183M, slowly BACKFILL the helium lines to 30 psi at PI2181H.

_____ [7] REPEAT steps 4 through 6 for two more evacuate/backfill cycles.

_____ [8] OPEN valves E2183M and E2195M.

_____ [9 RECORD in the Cryogenic Control Room Log Book that the compressor skid has been evacuated and backfilled.

5.6 Purge

Before operating on line, a compressor skid must be purged to remove impurities from the skid internals. This can be done by either using the compressor itself or the utility compressor in conjunction with the purifier.

5.6.1 Purge Using the Utility Compressor and Cryogenic Purifier

This procedure utilizes the utility compressor and the cryogenic purifier to clean up the gas within the compressor skid. Verify that the skid has been initialized and evacuated according to sections 5.2 and 5.5 of this OPM. Verify that the purifier and utility compressor have been configured according to C-A-OPM 7.1.9 section 5.9 (Compressor Room - Utility Compressor Operation, Configuring for Purging with Cryogenic Purifier).

_____ [1] CONFIRM all valves are configured according to the initial valve configuration in C-A-OPM-ATT 7.1.7.a.

_____ [2] Switch hand switch HS2199 into the "LOCAL" position.

_____ [3] Start the oil pump.

_____ [4] Slowly OPEN the purge supply valve H2183M.

_____ [5] Slowly OPEN the purge return valve H2190M.

_____ [6] RUN the purifier in this mode until the gas at the inlet to the purifier reaches an acceptable level of purity.

_____ [7] CLOSE valves H2183M and H2190M.

_____ [8] DEPRESSURIZE the compressor skid to 30 psi at PI2181H using the purge return valve H2190M.

_____ [9] STOP the oil pump.

_____ [10] RECORD in the Cryogenic Control Room Log Book that the compressor skid has been purged.

5.6.2 Purging Using a Main Compressor

This procedure utilizes the compressor on the skid being purged and the cryogenic purifier to clean up the gas within the compressor skid. Verify that the skid has been initialized and evacuated according to sections 5.2 and 5.5 of this OPM. Verify that the purifier has been configured

according to C-A-OPM 7.1.28 “Compressor Room- Cryogenic Purifier Operation”, and is ready to purify gas.

_____ [1] CONFIRM all valves are configured according to the initial valve configuration in C-A-OPM-ATT 7.1.7.a.

_____ [2] Switch hand switch HS2199 into the "PURGE" position.

_____ [3] OPEN the purge supply valve H2183M.

_____ [4] OPEN the purge return valve H2190M.

> **Note:**
> While purging a compressor skid in this configuration, the slide valve shall always be in the fully unloaded position.

_____ [5] START the compressor according to section 5.3 of this OPM.

_____ [6] Maintain purge supply and return pressures using the purifier controls.

_____ [7] RUN the purifier in this mode until the gas at the inlet to the purifier reaches an acceptable level of purity.

_____ [8] STOP the compressor according to section 5.4 of this OPM.

_____ [9] Switch hand switch HS2199 into the "LOCAL" or "COMPUTER" position.

_____ [10] CLOSE valves H2183M and H2190M.

_____ [11] DEPRESSURIZE the compressor skid to 30 psi at PI2181H using the purge return valve H2190M.

_____ [12] RECORD in the Cryogenic Control Room Log Book that the compressor skid has been purged.

5.7 Equipment Protective Interlocks

The following is a list of interlocks which will stop a second stage compressors from operating.

5.7.1 Gas Management Panel Master Shut Down

This interlock will shut down every compressor and pump motor in the RHIC compressor room. When activated, by depressing the emergency stop button on the panel, every compressor will stop and the blue "SKID RESET" lights will not be lit. Operators shall immediately notify the shift supervisor when this interlock is activated.

5.7.2 Differential Oil Pressure Low

This interlock activates if the differential pressure on DPSI2188E is less than 30 psi. When activated, a second stage compressor will not run. When activated the Operator should do the following:

> **Note:**
> This interlock will not activate for 1 minute after the oil pump has been started. This is to give the oil system a short time to balance.

_____ [1] CONFIRM that the bulk oil separator has approximately 6.5" of oil as viewed in the sight glass. If not, manually adjust the oil level.

_____ [2] RESTART the oil pump using the local hand switch HS2195. Allow the oil to circulate through the cooler, filter and compressor. Check that 30 psi is established between PI2188E and PI2181H. If not, adjust E2191P. Observe the pressure loss between PI2188E and PI2198E. This should be less than 15 psi. If not, change the oil filter element. Oil level will gradually decrease while the oil pump is operating and the compressor is not.

_____ [3] If neither step 1 and 2 will remedy the problem, the Operator shall inform the Shift Supervisor.

5.7.3 Cooling Water Flow Low

This interlock activates when the cooling water flow through the oil cooler is insufficient. When activated, a second stage compressor will not run. When activated the Operator should do the following:

> **Note:**
> This interlock is temporarily jumped out. It will activate its annunciator light but it will not shut down the compressor.

_____ [1] CONFIRM that both cooling water inlet and outlet valves are OPEN and adjusted properly.

_____ [2] CONFIRM that the main cooling water system is running.

_____ [3] If neither step 1 and 2 will remedy the problem, the Operator shall inform the Shift Supervisor.

5.7.4 Motor Winding or Bearing Temperature High

This interlock activates if the temperature in the compressor motors windings or bearings is over set limits. When activated, a second stage compressor will not run. The Operator shall inform the Shift Supervisor if this interlock activates. Under no circumstances shall the operator try to restart a compressor which trips off on this interlock without Shift Supervisor approval.

5.7.5 Bulk Oil Separator Level High

This interlock activates if the oil level in the bulk oil separator is over set limits. When activated, the redundant compressor will not run.

> **Note:**
> When first started, the compressor will run for 9 minutes with this interlock activated. This is to allow the compressors to discharge oil out of the separator and hence lower the level.

_____ [1] CONFIRM that the "OIL DUMP" hand switch (HS2169) is in the AUTO position. If it is, try emptying the separator by switching the switch to MANUAL.

_____ [2] CONFIRM that the oil make-up system is running properly.

_____ [3] If neither step 1 and 2 will remedy the problem, the Operator shall inform the Shift Supervisor.

5.7.6 Bulk Oil Separator Level Low

This interlock activates if the oil level in the bulk oil separator is under set limits. When activated, a second stage compressor will not run.

_____ [1] CONFIRM that the "OIL MAKE-UP" hand switch (HS2191) is in the AUTO position. If it is, try filling the separator by switching the switch to MANUAL.

_____ [2] CONFIRM that the oil make-up system is running properly.

_____ [3] If neither step 1 and 2 will remedy the problem, the Operator shall inform the Shift Supervisor.

5.7.7 Suction Pressure Low

This interlock activates if the compressor's suction pressure is under set limits. When activated, a second stage compressor will not run. The Operator shall notify the Shift Supervisor if the compressor trips off on this interlock.

5.7.8 Vibration High

This interlock activates if a compressor motor's vibration is excessive. When activated, a second stage compressor will not run. The Operator shall notify the Shift Supervisor if the compressor trips off on this interlock. Under no circumstances shall the operator try to restart a compressor which trips off on this interlock without Shift Supervisor approval.

5.7.9 Discharge Pressure High

This interlock activates if the compressor's discharge pressure is over set limits. When activated, a second stage compressor will not run. The Operator shall notify the Shift Supervisor if the compressor trips off on this interlock.

5.7.10 Discharge Temperature High

This interlock activates if the compressor's discharge temperature is over set limits. When activated, a second stage compressor will not run. The Operator shall notify the Shift Supervisor if the compressor trips off on this interlock.

5.7.11 Restart Lockout

Starting a compressor will initiate a restart lockout which will prevent restarting the motor in the event of a shutdown for a period of 60 minutes. Each compressor has its own restart lockout.

5.7.12 Valve Configuration Interlock

Besides the interlocks on the local skid annunciator panel, the compressors will not start unless either of the following conditions are met:

_____ [1] Both the skid Inlet and Outlet valves (H2176A and H2175M) must be OPEN. The compressor's slide valve must also be in the completely UNLOADED position.

_____ [2] Both the skid Inlet and Outlet valves (H2176A and H2175M) must be CLOSED, and the skid mode hand switch (HS2199) must be switched to "PURGE". The compressor's slide valve must also be in the completely UNLOADED position.

6. Documentation

6.1 The check-off lines on the procedure are for place-keeping only. The procedure is not to be initialed or signed, it is not a record.

6.2 The Shift Supervisor shall document the completion of the procedure in the Cryogenics Control Room Log

7. Reference

7.1 Drawing 3A995020, second stage HC compressor P&ID.

7.2 BNL Compressor Station Operating Manual Volume I as supplied by Koch Process Systems Inc.

7.3 C-A-OPM 7.1.5, “Compressor Room – Water System”.

7.4 C-A-OPM 7.1.9, “Compressor Room- Utility Compressor Operation”.

7.5 C-A-OPM 7.1.28, “Compressor Room – Cryogenic Purifier Operation”.

8. Attachments

8.1 C-A-OPM 7.1.7.a “ Valve Tables”.